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ABSTRACT

Several studies have reported adult age deficits in memory for prose materials. Adult age differences in prose comprehension were examined among young and old adults from high or low educational backgrounds. Subjects (N=53) listened to tape-recorded versions of two narrative passages and attempted to orally recall the stories. Subjects were compared on their abilities to comprehend prose and to differentiate the idea units of a passage in terms of their relative importance to the main theme. Results demonstrated that younger adults remembered more than older adults, but subjects from all age groups favored the main ideas in their recall. Subjects from all ages and educational levels were equally able to identify the important information in the stories. The findings suggest that little change with age occurs in the comprehension process, and that adult age differences observed on discourse comprehension tasks may reflect an age-related decline in processing capacity. (Author/NRB)

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Adult Age Differences in Sensitivity to
the Semantic Structure of Prose.

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Adult Age Differences in Sensitivity to
the Semantic Structure of Prose

During the past few years several studies have reported adult age deficits in memory for prose materials. Most of this research has been concerned with the quantity of information remembered (Gordon & Clark, 1974), the effects of presentation modality (visual vs. auditory) on retention performance (Taub, 1976; Taub & Kline, 1978) or on specifying whether adult age differences in performance reflect comprehension or retention problems (Taub, 1979). Recent work, conducted within the framework of contemporary models of discourse comprehension (e.g., Dixon, Simon, & Hultsch, Note 1; Meyer, Rice, Knight, & Jessen, 1979) has demonstrated that both older and younger adults favor the main ideas of a passage in their recalls. One problem with these studies has been the inconsistent occurrence of age differences in the amount information recalled, and thus it is difficult to specify the components of discourse processing that may underlie age differences in performance.

Current theories of discourse processing emphasize the importance of rapid verbal coding (Perfetti & Lesgold, 1977) in addition to the efficient execution of simple working memory operations (Kintsch & van Dyk, 1978). Rapid verbal coding allows more processing capacity to be available for the integration of information in working memory, thus facilitating the formation of a coherent text base (Kintsch & van Dyk, 1978). Recent research suggests

that verbal coding processes may require more cognitive capacity in older adults as they are slower than younger adults at retrieving word features (Walsh, 1976), word names, (Thomas, Foxard, & Waugh, 1977; Waugh, Thomas, & Fozard, 1978) and categorical information about words (Petros & Levin, Note 2) from semantic memory. These findings suggest that comprehension deficits in the elderly may be a result of the allocation of large amounts of processing capacity for rapid semantic access, effectively limiting the amount of working memory capacity available for comprehension processes.

In a related vein, Cohen (1979, Exp. 3) recently suggested that diminished processing capacity in older adults underlies an age related decline in language comprehension. Cohen found that older adults recalled significantly less story propositions and summary propositions than younger adults when a passage was auditorily presented at a fairly slow rate of speech (approximately 120 wpm). Cohen concluded that language comprehension was impaired in the elderly because of a diminished processing capacity, that was still exceeded by the demands of the recall task, despite the slow presentation rate. Diminished processing capacity in the elderly is not only suggested by adult age deficits on verbal coding tasks (e.g., Thomas et al., 1977; Petros & Levin, 1980), but also on short term memory scanning (Anders, Fozard, & Lillyquist, 1972; Anders & Fozard, 1973; Madden & Nebes, 1980), and divided attention tasks (Craik & Simon, 1980). However, the influence of

diminished processing capacity on discourse comprehension in the elderly is unclear from Cohen's study because the recall differences may reflect comprehension deficits or just poorer recall performance. Previous research suggests that comprehension should be measured by examining subjects' recall of prose as a function of the importance of the ideas in the passage (Brown & Smiley, 1977; Johnson, 1970). The assumption underlying this procedure is that comprehension will be reflected in an immediate recall that favors the main ideas of the passage relative to the nonessential details.

Recent work (e.g., Dixon et al., Note 1; Meyer et al., 1979) found that both older and younger adults will favor the main ideas of a passage in their recalls; however, presentation rate was not controlled in this work. Consequently, one purpose of the present study was to examine adult age differences in recall of prose as a function of the thematic importance of the idea units in the passage, when the passage was presented at a fairly slow rate of speech (120 wpm).

If adult age differences in discourse processing mainly reflect diminished processing capacity, then a similar pattern of recall should be observed between younger and older adults (i.e., favor the main ideas relative to the non-essential details) as both age groups would be sensitive to the semantic structure of the text, but older adults should remember less at all levels of importance. This would argue that language comprehension is not severely impaired in older adults, but their diminished processing capacity places a limit on the absolute amount of information retained. However, if older adults demonstrate an equivalent recall deficient for

idea units at all levels of thematic importance or demonstrate less sensitivity to importance than younger adults (Meyer et al., 1979), the difference may be resulting from diminished processing capacity in the elderly and/or an inability to distinguish among text units of differential thematic importance. This would argue for an age related decline in language comprehension, independent of any considerations of diminished processing capacity. Consequently, the present experiment also examined whether an adult age difference occurs in a subject's sensitivity to the thematic importance of the idea units of a passage. Specifically, young and old adults rated the thematic importance of the idea units in a passage (Brown & Smiley, 1977).

Perlmutter (1978) has recently argued that age differences may either be the result of culturally related generational differences (e.g., cohort effects), or developmental age changes. In the present study, the most relevant type of potential cohort effect involves the educational level of the subject, which is likely to be an important factor influencing their performance. Therefore, the variables of age and educational level were orthogonally manipulated in order to directly assess each of their effects and attempt to circumvent possible problems in interpretation.

Furthermore, age and educational level have similar effects on verbal coding speed in both young adults (Chabot, Petros, & McCord, 1981) and older adults (Petros & Levin, Note 2). Therefore, if verbal coding speed plays an important role in adult-age differences in discourse processing, then manipulations of the variables of age and educational level should produce a similar

pattern of results.

Thus, young and old adults from high or low educational backgrounds will be compared on their ability to comprehend prose. Furthermore, they will also be compared on their ability to differentiate the idea units of a passage in terms of their relative importance to the main theme.

Method

Subjects

Fifty-three adults (25 males, 28 females) served as subjects in the present study. There were an approximately equal number of subjects in each of four Age X Education Groups. The younger subjects from the low education group ($N = 13$) were between the ages of 18-5 and 28-7 (mean = 20 years 6 months) and were in their first year of undergraduate studies. The younger subjects in the high education group ($N = 14$) were between the ages of 21-10 and 30-9 (mean = 27 years 6 months) and were nonpsychology graduate students who had received between 16.75 and 19.50 years of education (mean = 18.12). The older subjects in the low education group ($N = 13$) were between the ages of 62-7 and 80-11 (mean = 71 years 7 months) and were residents of the local community. These subjects had completed between 8 and 15 years of education (mean = 11.88). Finally, the older subjects in the high education group ($N = 13$) were between the ages of 64-9 and 79-5 (mean = 71 years 6 months) and were emeriti university faculty. Subjects from this group had received between 17.0 and 20.0 years of

education (mean = 19.46). All of the subjects were recruited by phone and offered \$5 for participating.

Design

The design of the present study for the recall data involved two between subjects factors and two within subjects factors. The between subjects factors were Age (Young, Old) and Education Level (High, Low) while the within subjects factors were Story Order (Story 1, Story 2) and the Importance Level of the text units (Level 1, Level 2, Level 3, Level 4). The design for the rating data involved the variables of Age, Educational Level, Story, and Importance Level.

Materials

Two Japanese folk tales, employed by Brown et al. (1977) were selected as stimulus materials. Each of the stories were of a grade five reading difficulty (390 and 403 words) and previously had been divided into idea units by young adults. Each idea unit was also rated for its importance to the theme of the story using a four-point scale. On the basis of these importance ratings, the idea units of each story were ranked from least to most important in such a way as to insure that the number of idea units at each level was approximately equal (Brown et al., 1977). The resultant four sets of units, corresponding to the four levels of importance, were used as the measure of rated importance against which recall performance was compared. Furthermore, these ratings also served as the norm for evaluating the rating data.

Procedure

All subjects were tested individually in a private experimental room. Each subject was presented with a tape recorded version of both target stories, recorded at a fairly slow rate of speech (approximately 120 wpm). The order in which the specific stories were presented was independently counterbalanced within each Age X Education Group.

Subjects were told to listen carefully and try to remember as much as possible since they would be asked to retell each story after it was presented. Immediately after listening to each story, subjects were allowed approximately one minute to organize their recalls and then attempted to orally reproduce the story. They were instructed to remember as much of the story as possible, but not to worry about the exact wording. Their recalls were tape recorded and transcribed for scoring purposes.

After recall of both stories was completed, subjects were presented with one of the target passages and asked to rate its idea units in terms of their importance to the theme of the story. All subjects rated the second story presented to them. The general procedure for rating the thematic importance of the idea units in a story was taken from Brown and Smiley (1977). All subjects first read the story at their own rate. The stories were printed with one previously identified idea unit typed on each line. After reading, subjects were told that the individual idea units differed in their importance to the theme of the story and some less important idea units could be eliminated without

destroying the main theme. They were first instructed to eliminate N units (about 1/4) which they felt were least important by crossing them through with a blue pencil. They then were requested to eliminate N (1/4) more idea units that could be removed without destroying the main theme, using a red pencil. Finally they were asked to repeat this procedure again with a green pencil, leaving a quarter of the original units exposed. It was emphasized that the remaining units should, in their judgment, be the most important ideas in the story. After the rating procedure was completed, subjects were administered the vocabulary subtest of the WAIS in order to give us an additional measure of the verbal abilities of our subjects.

Results

Recall Data: All recall protocols were scored (blind) for the presence or absence of the gist of each idea unit. Furthermore 30% of the protocols of each group were randomly selected and independently scored (blind) by a second rater, resulting in an interrater reliability of .91. Memory for each passage was expressed as the proportion of idea units recalled at each of four levels of thematic importance. These recall scores were subjected to a 2(Age) x 2(Education Level) x 2(Story Order) x 4(Importance Level) mixed ANOVA.

A significant main effect of age was observed, $F(1, 49) = 8.22$, $p < .01$, with young adults recalling a greater proportion of idea units ($M = .63$) than older adults ($M = .55$). Also a significant main effect of Education Level, $F(1, 49) = 6.81$, $p <$

.01, revealed that high education subjects recalled more idea units ($\bar{M} = .62$) than low education subjects ($\bar{M} = .55$). Furthermore, a significant main effect of Story Order, $F(1, 49) = 10.58, p < .01$, indicated that subjects recalled more idea units from the second story presented ($\bar{M} = .61$) than the first ($\bar{M} = .57$). Finally, a significant main effect of Importance Level, $F(3, 147) = 342.40, p < .01$, was also observed. Neuman Keul's analysis of this main effect indicated that recall declined as a function of the importance level of the idea units (level 4 > level 3 > level 2 > level 1, $p < .01$).

In addition, a significant Age X Importance Level interaction, $F(3, 147) = 2.86, p < .04$, resulted from this analysis (see Table 1). Subsequent analysis of this interaction (Neuman Keuls)

Insert Table 1 about here

revealed that younger adults recalled more idea units than older adults at all levels of importance; however, the difference seemed greatest for the least important idea units. Furthermore, recall declined as a function of the importance level of the idea units for both age groups. Finally, a marginal Education X Importance Level interaction, $F(3, 147) = 2.86, p < .08$, was also observed. Although no post hoc tests were done, an inspection of Table 1 indicates that high education subjects recalled more than low education subjects at all levels of importance; however, the difference appears greater for the less important idea units.

In light of the practice effect suggested by the Story Order main effect, a $2(\text{Age}) \times 2(\text{Education Level}) \times 4(\text{Importance Level})$

mixed ANOVA was conducted separately for the recall scores from the first story and second story presented. Essentially, both analyses revealed significant main effects of Age, Education Level, and Importance Level, with all other effects being non-significant. The non-significant interactions of Age x Importance Level and Education x Importance Level challenge the robustness of these interactions which were reported in the overall analysis. Regardless, age and education differences were significant at each level of importance.

Rating data: In order to examine whether the above recall differences were contributed to by a differential sensitivity among our subjects to the thematic structure of the text, we examined the rating data. Two methods were used to compare the importance ratings of our subjects with those of the normative sample. First, the mean importance rating for level 1, level 2, level 3, and level 4 idea units was computed for each subject and these scores were subjected to a 2(Age) x 2(Education Level) x 2(Story) x 4(Importance Level) mixed ANOVA. Significant main effects of Story, $F(1, 41) = 5.38, p < .03$, and Importance Level, $F(1, 123) = 669.76, p < .01$ were found along with a significant Story x Importance Level interaction, $F(3, 123) = 2.98, p < .04$. No significant effects involving Age or Education Level were found in this analysis. The significant effects that involved Story indicated that one story received higher importance ratings than the other, especially for level 3 and level 4 idea units. Furthermore, a Neuman Keuls analysis of the Importance Level main effect revealed that rated

importance increased as a function of importance level ($1.53 < 2.11 < 2.79 < 3.51$, mean ratings for levels 1-4 respectively; $p < .01$). Thus, subjects at all ages and education levels were equally sensitive to the thematic importance of the idea units in the stories.

As an additional check of the correspondence between the importance ratings of our subjects with those of the normative sample, the mean importance rating for each idea unit was computed for each of the four groups in the study and compared with those of the normative sample by computing Pearson Product Moment correlations. The correlations between the normative sample and each of the four groups were high and significant for both stories, ranging between .80 and .91. These correlations again indicate that subjects at all ages and education levels were equally sensitive to the thematic importance of the idea units in the stories.

Wais scores. A scaled score was computed for each subject based on their number correct and their age appropriate norms and these scores were subjected to a $2(\text{Age}) \times 2(\text{Education Level})$ ANOVA. A significant main effect of Education Level, $F(1, 49) = 14.71$, $p < .01$, was found with all other effects being non-significant. Thus the high education subjects had a higher level of verbal ability (mean = 15.13) than the low education subjects (mean = 12.92) but both age groups were approximately equivalent in their verbal abilities.

Discussion

The results demonstrate that both young and older adults are sensitive to the thematic structure of text and exhibit a similar pattern of comprehension. These results are consistent with previous work (Dixon et al., Note 1; Meyer et al., 1979; & Rebok, Hall, Smith & Smith, Note 3) in demonstrating that subjects at all ages favor the main ideas in their recalls relative to the non-essential details. Furthermore, the rating data complement the above results by indicating that older and younger adults were equally sensitive to the different levels of thematic importance of the text units. Therefore, sensitivity to the thematic structure of prose, or other metacognitive aspects of the comprehension process (Zelinski, Gilewski, & Thompson, 1980) do not seem to be a major component of adult age differences in discourse comprehension.

The results of the present study suggest that language comprehension is not severely impaired in older adults as both ages demonstrated similar patterns of recall. However, Cohen's (1979, Exp. 3) results suggest a much larger age-related deficit in language comprehension than indicated by the present study because large age differences were found in the recall of summary propositions, which presumably correspond to the gist of the passage. Cohen; however, used a variant of the Circle Island story (Dawes, 1966) which discusses a political conflict between two tribes on a fictional island. Possibly, the passage used by

Cohen lacked the general interest value of the simple narrative materials used in the present study, and thus may have comprised a more difficult text. This speculation receives some support from the results of Meyer et al. (1979) and Dixon et al. (Note 1) who found the largest age differences in recall for the most important units of the story. These authors employed passages about specific contemporary topics that may have lacked the general interest value of the narrative materials used in the present study. Although these speculations require future empirical support, they are consistent with the arguments of recent memory theorists (e.g., Brown, 1975; Anderson, 1978) who emphasize that the compatibility of the text (i.e., difficulty, topic) with the background knowledge and interests of the subject is an important determinant of comprehension.

The primary result of the present study is that sensitivity to the semantic structure of prose is not a major component of adult age differences in prose comprehension. The question remains as to what might be producing the age differences observed in the present study? A consideration of the requirements of prose processing provides some suggestions as to the locus of these age differences. For example, prose comprehension requires rapid processing of a continuous input in conjunction with memory for earlier portions of the text. Processing capacity must be divided between continuous decoding of the text and maintaining text propositions in working memory. Maintenance of text propositions in working memory should facilitate the integration of various text propositions and thus improve comprehension (Kintsch & van

Dyk, 1978). Therefore, within this model, the functional capacity of working memory (Daneman & Carpenter, 1980) is an important determinant of comprehension performance and any processes which influence this capacity and vary among individuals should account for comprehension differences.

Verbal coding speed and the efficiency of short term memory scanning should theoretically limit the functional capacity of working memory, and are major sources of individual differences in reading comprehension (Wess & Radtke, 1981; Kail, Chi, Ingram & Danner, 1977; Perfetti & Lesgold, 1979). Furthermore, adult age differences are also found for verbal coding speed (Thomas et al., 1977; Petros & Levin, Note 2) and the efficiency of short term memory scanning (Anders et al., 1972, 1973; Madden et al., 1980). Consequently, verbal coding speed and the efficiency of short term memory scanning should limit the functional capacity of working memory in older adults, and thus cause the diminished processing capacity referred to earlier (e.g., Cohen, 1979). While the results of the present study do not directly suggest that slower verbal coding speed and short term memory scanning produced the age differences of the present study, the parallel effects of age and educational level suggest that age-related differences in prose comprehension reflect differences in verbal proficiency (Hunt, 1980). However, an examination of adult age differences in comprehension when passages are presented at several different rates is needed to more directly specify the contribution of verbal coding speed and short term memory operations to adult age diff-

erences in discourse comprehension. Future work should systematically explore various discourse processing variables (e.g., rate of presentation, passage difficulty) that should influence the speed of verbal coding and short term memory operations, and examine the resulting effects on comprehension. It may be that age differences in sensitivity to semantic structure will emerge only in cases of a severe processing overload, i.e., when processing a difficult passage presented at a fast rate.

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TABLE 1

Recall as Function of Age and
Importance Level

Age	Importance Level			
	Level 1	Level 2	Level 3	Level 4
Young	.487	.498	.649	.871
Old	.369	.456	.560	.812

Recall as a Function of Education and
Importance Level

Education	Importance Level			
	Level 1	Level 2	Level 3	Level 4
High	.459	.515	.659	.859
Low	.397	.439	.551	.824